Chapter 1

Installation and Commissioning - WBS 1.5.5

LAr20 construction and installation will occur in several distinct phases:

- Installation planning and prototyping.
- Surface storage identification and operation.
- Excavation and outfitting of the cavern. This activity is the responsibility of WBS 1.6.
- Construction and installation of the cryogenics system and cryostat at DUSEL by a contractor. The contractor will provide construction management. This activity is the responsibility of WBS 1.5.2.
- Construction of LAr20 detector components at collaborating institutions and shipment to DUSEL. This activity is the responsibility of WBS 1.5.2 - 1.5.7
- Installation of detector components at DUSEL. Installation management is provided by this WBS.
- Commissioning of LAr20 with management provided by this WBS.

The Installation and Commissioning system will accept responsibility for the LAr20 cavern, associated tunnels, infrastructure and above ground facilities from WBS 1.6 upon completion of the excavation contract. The cavern will be outfitted with the following utilities upon receipt of beneficial occupancy:

- Ventilation in accordance with OSHA standards and independent of the existing DUSEL facility.
- Electrical power sufficient for the HVAC, cryogenics plant cooling, electronics and general 110 V service.
- Communications consisting of 3 telephone lines and computer network.
- Cavern lighting in accordance with OSHA regulations for industrial use.
- Tunnel lighting with battery powered backup or emergency circuit backup.
- Environmental monitoring of oxygen, carbon monoxide, smoke and temperature.
- Dual isolation bulkheads separating the cavern from the existing DUSEL facility.
- Sump pumps for ground water removal.
- A light monorail crane located over the cryostat **FIXME:** *confirm this with JA*

Area responsibility will immediately be transferred to the cryogenics and cryostat contractor, who will retain responsibility for the site during construction. The Cryogenics & Cryostat WBS will provide oversight during this phase. Upon completion of this contract, the facility will be in the following state:

- the LN2 refrigeration system will be constructed and commissioned with liquid nitrogren. **FIXME:** *confirm this*
- the LAr systems and cryostat will be constructed and tested without the introduction of cryogens. The personnel access hatch on the cryostat and the cryostat chimneys will be temporarily sealed.
- the APA and CPA installation monorails are in place.
- the temporary floor in the cryostat will be left in place.

The Installation and Commissioning system will be responsible for all LAr20 related activities at the far detector site from this point in time to the end of the LAr20 project. Close coordination is clearly required between the I&C WBS, provider systems and other DUSEL construction activities.

On-project commissioning activities include the coordination of system checkout activities, culminating in the approval to introduce liquid argon into the detector, and managing the steps required to meet the CD-4 goals.

The responsibility and authority for the design, installation and use of the detector quiet power distribution and detector grounding system is held by the electrical project engineer. All attachments to the detector that create an electrical connection are done under the oversight of the electrical project engineer. The engineer has oversight responsibility for all electrical and electronics design and installation tasks. **FIXME:** *This text belongs somewhere else.*

1.0.1 Installation Prototype

An installation and integration detector mock-up will be constructed at Fermilab to confirm that interfaces between detector systems are well defined and to refine installation procedures. A mechanical mock-up of several APA's will be constructed. The APA mock-ups will include all mounting points and interface points such as optical fiber readout cables and power cables. A mock-up of a section of the cryostat will be constructed in a suitable location at Fermilab, e.g. CDF or DZero. The cryostat section will include a representation of the roof hatch, APA supports and feedthroughs.

1.0.1.1 Surface Storage Facilities

A surface storage facility on the DUSEL site will be identified and an agreement made for it's use during construction. The surface storage facility will be made available to the cryogenics system contractor (?) and will be responsible for all activities in this facility during the contract period. The cryostat insulation will comprise the largest bulk of material; approximately 5500 m^3. Figure 1.0.1 shows membrane cryostat components staged in the hull of an LNG tanker under construction. Control of this area will revert to the Installation WBS when the contract is completed.

Detector components will be delivered to DUSEL over a period of many months and will be stored in the surface storage facility. APA's will be constructed elsewhere, electronics installed and cold testing performed. They will be shipped in sealed shipping containers as shown in figure 1.0.2. No significant preparation or testing of APA's is required prior to installation.

1.0.1.2 Cryogenics Receipt

Delivery of liquid argon will occur over a 4 - 6 month period of time with approximately 8 tank trucks/day arriving on site. Each tank truck will have been loaded with 18.8 Tons of LAr but minor losses

will occur during shipment. Transfer of the liquid argon out of the tank truck will require 1 hour, including the time for making hose connections, purging hoses, etc. As described in section xxx, the liquid argon purity is tested by the vendor before the truck departs for DUSEL. The purity is checked again during unloading. The partially emptied tank truck will be returned to the vendor if the purity is found to exceed the require specification.

Liquid argon will be stored temporarily in a buffer tank sized to hold one tank truck load and will be immediately pumped from the tank to the detector cryostat.

1.0.2 Below-ground Pre-Installation

This WBS will provide minor improvements to the below-ground infrastructure such as signage, installation tools, a martini bar and cavern access controls. Cavern access controls will include a mechanism for checking the training status of personnel, badge-in/badge-out procedures and closed circuit television monitoring of the entrance portal.

Only trained personnel will be allowed below-ground. Members of the installation crew will be trained on specific installation tasks and must pass a qualification test. The training will likely use mock-up APA's constructed for the installation prototype described above. The training program will be modeled after the Fermilab "NuMI underground training" and will be developed in collaboration with DUSEL ES&H personnel.

This WBS will develop and implement the procedure for monitoring the integrity of the membrane cryostat primary liner during installation. The space between the primary liner and the secondary liner will be held under vacuum during installation. The vacuum level will be automatically monitored and will alarm if a dropped object has punctured the primary liner.

1.0.3 Below-ground Installation Activities

The installation sequence will proceed as follows:

1. Move installation and access equipment into the cryostat.
2. Install cryogenic feedthroughs and dress cables.
3. Install protection on (or remove) existing cryogenics instrumentation in the cryostat.
4. Install purity monitors and other instrumentation.
5. Construct the far end field cage.
6. Transport APA and CPA shipping boxes into the cavern.
7. Install detector cells:
   (a) Install three APA's and four CPA's.
   (b) Connect power and signal cables.
   (c) Test each APA wire for expected electronics noise. Spot check electronics noise while cryogenics equipment is operating.
   (d) Install top and bottom field cage sections.
   (e) Perform electrical test on CPA's and field cage.
8. Install the near end field cage.
9. Temporarily seal the cryostat and test all channels for expected electronics noise.

10. Seal the access hatch.

11. Final test all channels for expected electronics noise.

1.0.3.1 Cryostat Cleaning & Purging

The cryostate cleaning and purging procedure is described here. I am assuming that no cryogens will be introduced to the detector prior to commissioning. Some thought needs to be given to the optional LAr storage system and how this system would be approved for use with cryogens.

1.0.4 Detector Commissioning

We need to have an idea of the CD-4 goals before this section can be written.

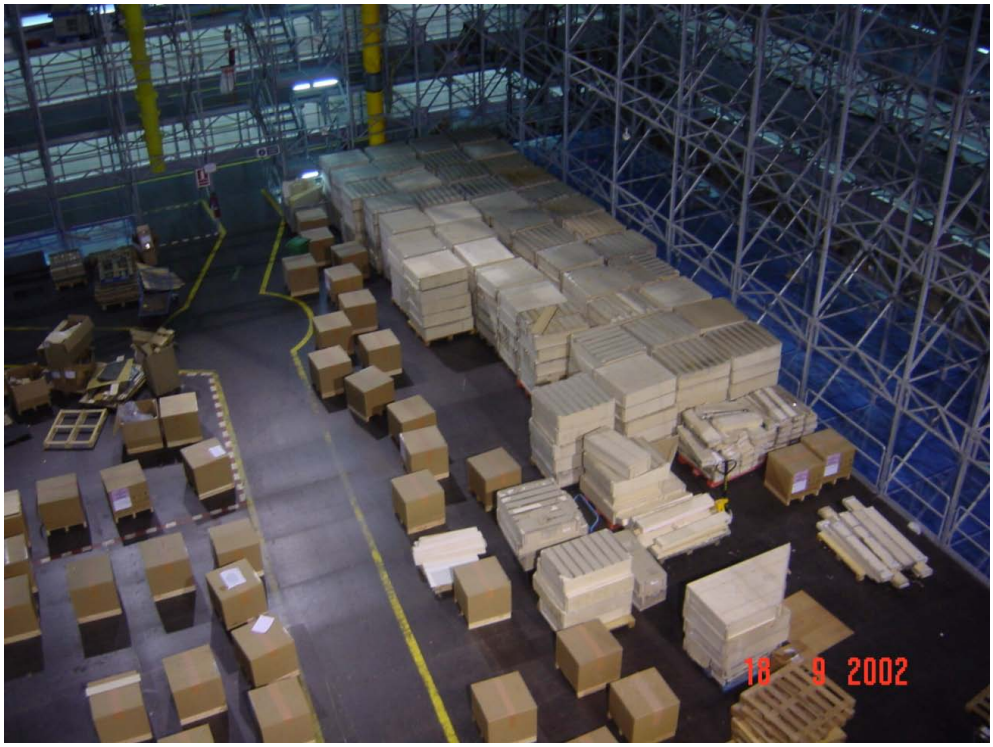

Fig. 1.0.1. Membrane cryostat components staged in a LNG transport ship under construction.

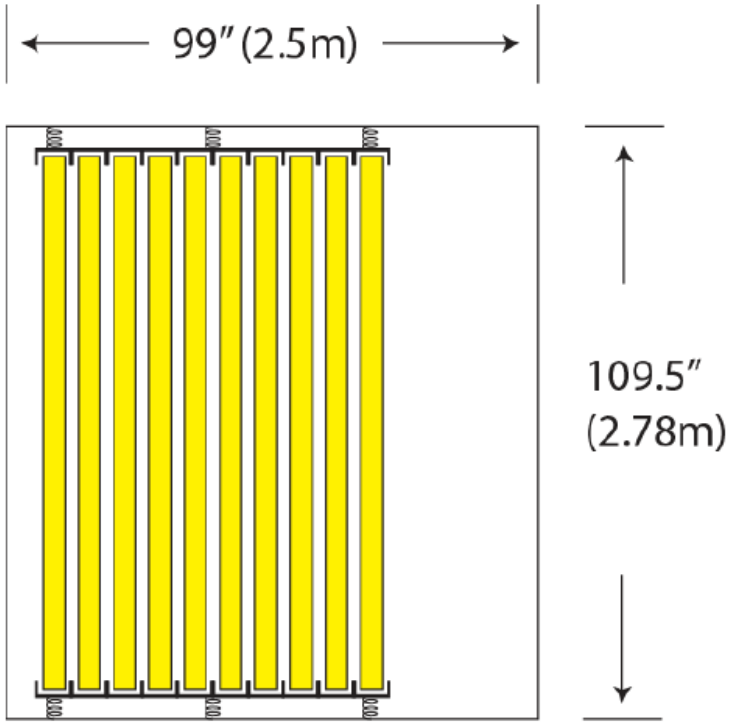

Fig. 1.0.2. APA shipping container concept.

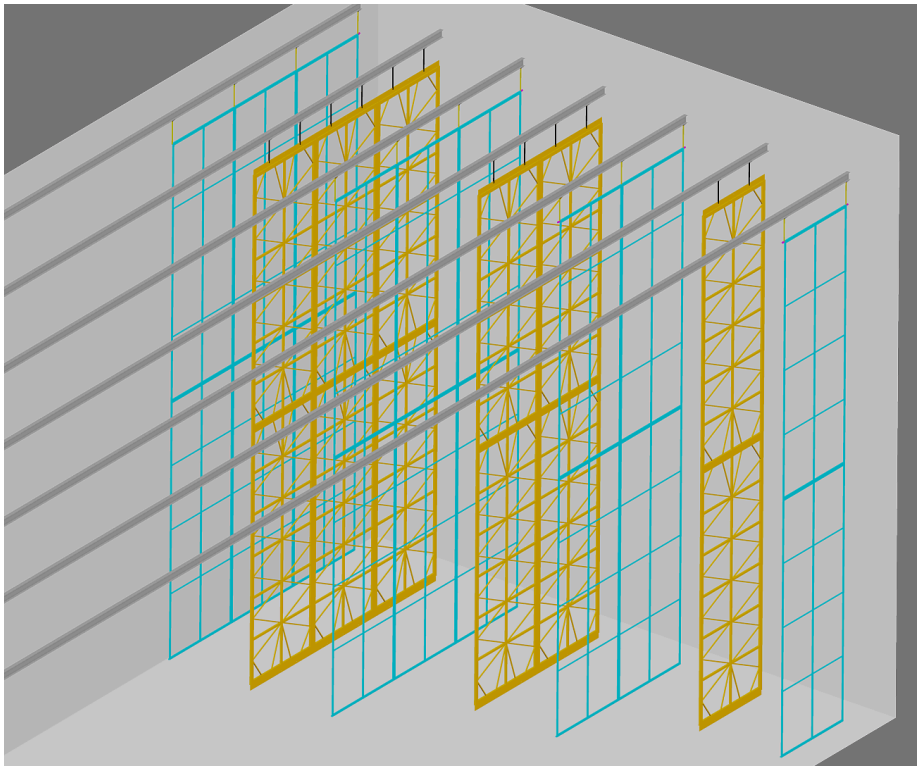

Fig. 1.0.3. TPC Installation scheme